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The Effects of Home Video Games on Television Receivers

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U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, Secretary

Dr. Sidney Harman, Under Secretary

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Preface

This report describes the results of a short investigation on the effects of home video games on television receivers for the Federal Trade Commission. The length of the study and the funding level did not allow an indepth investigation. As a result, the number of games and number of television receivers tested is limited. As noted under "Significance of Laboratory Evaluations" only one game and one receiver were used for any particular test. Effects of interactions of the various games, receivers, and factors examined were not determined. Visual rather than optical measurements have been used. The purpose of the study was to determine if a potential problem exists in terms of video games producing objectionable permanent patterns on television receiver screens and was not intended to fully define any problem that exists or determine all possible actions that would reduce such a problem.



Introduction

This report describes the results of a brief analysis on the potential problem of video games, some of which have been known to produce a permanent pattern on the screen of television receivers. A laboratory evaluation was made to put in perspective the primary factors which appear to affect the problem.

A review of the data subpoenaed by the Federal Trade Commission from manufacturers of TV receivers, games, and picture tubes shows that the majority of complaints have come from dealers who have displayed the games on receivers for extended periods. The primary complaint has been an objectionable pattern which is permanently burned into the screen of the receiver. The stationary pattern formed by the outline of the game is most noticeable when the set is turned off and often is visible during regular broadcast reception. The pattern imprinted on the screen was judged by many dealers to be so objectionable that the set could not be sold. On the otherhand, there have been extremely few consumer complaints of this problem when the game is used intermittently in the normal manner. The only explanation is that these early games did not get used for a sufficient number of hours to develop an objectionable pattern. Information is not available on the typical range of hours per year of video game use by consumers.

As further evidence that the problem of browning is not being experienced by consumers is that a major television manufacturer has inspected over 300,000 picture tubes returned for rebuilding. There has not been a single report of a tube which has any patterns on the face. This company has spent considerable time and effort in trying to define the problem and the fundamental causes by performing their own tests and setting up task forces. In general their tests have shown that discoloration can occur in about 20 hours of continual use. Monochrome (black and white) tubes apparently discolor about twice as much as color tubes and that after about 150 hours of continual use for monochrome tubes a saturation level is achieved, that is, continued use will not cause significant further browning. Also they have observed that in some cases the browning would diminish by itself from exposure to ambient light and normal use with program material. The disappearing phenomenon is apparently not completely well understood. Tests at a glass manufacturer have shown that the visible pattern on the screens of tubes is due to what is called x-ray browning of the glass. The glass manufacturer and a television receiver manufacturer have shown that light exposure and/or baking can cause the discoloration to disappear.

Some game manufacturers have recognized the potential problem and have modified their games either by reducing the peak-white modulation level or devising more sophisticated techniques. On the otherhand, some game manufacturers have not admitted to problems despite tests with their games

by others which have shown them to produce permanent patterns on TV receiver screens.

Games Examined

A total of nine different manufactured games were acquired for examination and test in the laboratory. The games selected ranged from the inexpensive simple ball and paddle types to the new programmable types which offer a wide variety of games by means of removable cartridges. Also, the selection of some of the games was based on those which have been tested and reported by others to cause objectionable patterns.

The modulation levels of each of the games was measured with an oscilloscope. Table 1 lists each of the games and the measured levels of modulation for the peak white and the black level signal referenced to the sync-peak amplitude.¹ In this report games referred to as high modulation games means that the peak-white amplitude is between 10 and 24 percent. Reduced modulation games are those with a peak-white amplitude in the range of 25 to 50 percent.

Laboratory Evaluations

Four different laboratory experiments were performed. In the first three, games with different modulation or operating cycles were each

¹The American system for modulation of television signals is negative amplitude modulation, that is, increasing light produces a decrease in carrier amplitude. The sync-peak amplitude represents the maximum peak power capability of the signal and therefore is referenced at 100%. The standard for black level amplitude is 75% and the peak-white amplitude is 15%.

connected to four television receivers; two color and two monochrome receivers, one of each pair at normal brightness control setting and one at the highest useable brightness control setting. The fourth game was connected only to a monochrome receiver at high brightness which had been found to be the worst case test (shortest time for a visible pattern).

The first three experiments were designed to provide comparisons of three factors reported to affect the operating time for patterns to develop or the severity of pattern that might occur in a given amount of operating time

The three comparisons are as follows:

1. The effect of high vs normal receiver brightness control settings.
2. The effect of continuous game operation vs game operation interspersed with broadcast program reception.
3. The effect of a high modulation game signal vs a reduced modulation game signal.

The 4th experiment evaluates a unique technique used in game D which continuously varies the luminance (brightness) and color of the game

pattern if the game is left on but is not being played. Each experiment will be discussed separately. All laboratory evaluations were judged visually by the same observer across all of the experiments using the rating scale and criteria shown in Table 2. Quantitative optical measurements have been made by one TV receiver manufacturer but the time and funding of this evaluation did not allow this sophistication. The experimenters opinion of the possible user reaction to each level is given. Based on the assumption that these reactions are correct, the critical level which would result in significant consumer dissatisfaction is level 3. The operating time for any visible pattern to reach this level has been used as the basis for comparison of the factors which may affect pattern development time or severity.

High vs Normal Receiver Brightness

The results of the comparison of high vs normal TV receiver brightness control settings are shown in Table 3. The table shows the operating hours to reach a level 3 pattern for one color and three monochrome receivers which were used with three different games. Note that in most cases operating the receiver at high brightness control Table 4 game C settings decreases the operating hours to reach a given pattern level. The practice should be discouraged since for some games a level 3 pattern will occur on monochrome receivers in about 100 hours of game use. Since for some games, level 3 patterns occur in a few hundred hours of use even at normal

brightness settings, receiver control adjustment alone will not eliminate consumer complaints.

Fig. 1 is a photograph of the screens of two monochrome receivers displaying the fixed pattern produced by game B. The upper screen is on the set that has the brightness control set to a high level. The lower screen displays a normal brightness setting. Fig. 2 shows the resultant pattern left on each of the receiver screens after approximately 280 hours of game time. As mentioned previously and it can be noted in Fig. 2 the severity level of the retained pattern for a given number of hours is always somewhat greater with the set adjusted for high brightness.

Comparison of Cycle vs Continuous Game Operation

Game B was operated on a cycled basis. The receivers displayed the game outline for 2 hours and then broadcast programs for 4 hours. This cycle continued 24 hours a day. The cycle is intended to more closely simulate the use of a TV receiver and game in the home. The receiver was not turned off during the cycle because a limited time was available to accumulate enough game operating hours. Game C was displayed continuously. The test was designed to verify reports that the game hours to result in any pattern in normal intermittent use is much longer than the hours of continuous game operation which results in the same pattern level.

The results of this comparison are shown in Table 4 for the game B which was cycled and game C which was operated continuously. Both are high modulation games; the possible differences between the games should be examined in Table 3. Comparable pattern levels for continuous and cycled games occurred only on the monochrome receivers. For the high brightness receivers there is no significant difference in the hours at all. There appears to be a difference in the hours of somewhat less than two to one for the normal brightness setting receivers. For repeated intermittent game use periods, separated by hours or probably days, there does not appear to be a large difference in the number of operating hours required to develop a given pattern level as compared with continuous use. The pattern development is approximately proportional to game hours regardless of how they are accumulated. In other words if patterns occur in continuous operation in a number of operating hours that the game is likely to be used, it appears that the same severity of pattern is likely to eventually occur in normal use after a similar number of operating hours.

Figure 3 shows a card game format produced by one of the cartridges supplied with game C on a 19-inch monochrome receiver. The image remains stationary if the game is not played. Although portions of the format are in color if used with a color receiver, the score numbers at the top are white on a black background at maximum modulation. Figure 4 shows the screen of the same set turned off after about 430 hours of continuous game operation. However, as shown in Table 6 a level of 3 was achieved in less

than 100 hours, when used with a monochrome receiver. The degree of severity shown here would doubtless be judged by most to be highly objectionable. It is interesting to note that the manufacturer of this particular game in response to specification five of the FTC subpoena reported that no burns of any nature were observed in any of their tests and so has concluded that there is no problem.

Comparison of High Modulation vs Reduced Modulation Game Signals

A game design technique that has been adopted by several manufacturers to increase the operating hours before any pattern develops is to reduce* the maximum modulation level of the game signal. The effect on the picture is to reduce the brightness and contrast of the picture from the maximum attainable for any given receiver control settings. If the receiver controls are adjusted for a normal picture on a broadcast program as usually recommended in the game instruction book and then switched to the game, the game picture will have low brightness whites or light colors and grey rather than true black tones.

Game B is a high modulation game capable of the maximum white level defined by TV broadcast standards. Game A is a reduced modulation game with a white level typical of reduced modulation games. Both were operated on the cycle of 2 hours game and 4 hours broadcast program previously described. The results of this comparison are shown in Table 5. None of

*In Table 1, games B and C are high modulation games. All others have reduced modulation.

the 4 color-receivers connected to these games reached level 3 and are not included in the table. On the high brightness monochrome receivers, the reduced modulation game required 3 times the operating time to reach level 3. For the normal brightness monochrome receivers, the reduced modulation game accumulated twice the hours at which the high modulation game reached level 3 without reaching that level. This time corresponds to one hour a day for a year. This seems like a large number of game playing hours but would be accumulated in 2 weeks of continuous operation if a game and receiver were left on.

Evaluation of Variable Luminance Levels

Of the games evaluated in the laboratory, only game D had a unique design feature which was judged to be intended to prevent any pattern on the tube even after prolonged operation. The playing time of any game ends after about 2-1/4 minutes or if a player scores 100 points. The game then leaves the final picture on the screen but continuously switches the luminance (brightness) and the color of each element in the picture. This technique subjects all parts of the screen to about the same average luminance over a long period of time. This results in an overall browning of the tube face glass similar to what normally occurs in viewing broadcast programs.

This game was connected only to a monochrome receiver with high brightness settings which is the worst case, a condition which will produce any pattern in the shortest time. The results of this test are shown in the right hand column of Table 6.

Game D would not have caused any visible pattern except for the fact that the rectangular playing area did not cover the entire face of the tube. This effect is intentional in the design and prevents parts of the game picture from being off the edges of the screen on some receivers. On the monochrome receiver used in the test, and several others, this game has a blank band at the top and left edge of the tube. A faint outline of the playing rectangle is visible at these locations. The pattern was still judged to be a level 2 after over 400 hours of operation. However, it probably would not be seen by most observers.

Significance of Laboratory Evaluations

The results of all tests are shown in Table 6 for the 4 games and 13 TV receivers operated in the laboratory. Since only one game and one receiver for any particular control setting or operating cycle used, the results should only be considered trends and not representative of what will result for any individual game, receiver or user. Additionally, the color receivers and monochrome receivers were not all the same model but each pair used for normal and high brightness settings were the same model.

Operating time differences of less than 10 hours for the cycled games and 30 hours for the continuously operated games are not significant due to observation gaps during weekends when rating changes may have occurred.

Conclusions

It is obvious from these tests that eventually most electronic video games can produce some level of a permanent pattern on the screens of most television receivers. These results could be achieved in various ways by users failing to turn the game or television receiver off at the end of game play. One can envision several possible habits of users which could result in a large number of accumulated game hours. For instance several hours could accumulate regularly if children leave the room to go out to play without turning the game off or leave the game and television receiver on all night. The worst condition that could occur would be if the game and receiver were inadvertently left on while on vacation. Even the reduced modulation games would cause an objectionable pattern on a monochrome receiver in two weeks of continuous operation. Because of the above possibilities some additional measure is necessary to prevent pattern development if the game or receiver is not turned off after play. The technique of varying the luminance levels over the entire screen after play which was previously described in the evaluation of variable luminance levels is an effective one. Another technique reported by one manufacturer is that after 90 seconds of inactivity the game will switch the signal to

produce a blank screen on the receiver. This game was not examined in the laboratory but the technique would certainly be effective. There may be other design techniques which could be incorporated in new game designs.

All video games examined in the laboratory were found to cause some degree of visible, but not necessarily objectionable, pattern on the screen of monochrome television receivers within one to two-hundred hours of game use. Color television receivers are less susceptible so that only games with high signal modulation will cause some degree of a visible pattern on the screen in a similar number of hours of game use.

There are many factors which affect the ultimate severity and time for a pattern to become visible. The primary factors which were shown to have the greatest effect are:

1. type of receiver, color or monochrome
2. the signal modulation level of the game
3. the brightness and contrast settings on the receiver.

Limited testing indicates that the degree of pattern development is approximately proportional to the total accumulated game operating hours

regardless of whether the use is continuous or interspersed with normal broadcast reception.

Reducing the modulation level of the game signal is an effective way of extending the number of operating hours before any given level of pattern develops. Games with a reduced level of modulation produced no objectional pattern on any receiver in over 300 hours of game use and no visible pattern was observed on color receivers in the same number of hours of game use. However, games with high levels of modulation were found to produce objectional patterns on the screens of monochrome receivers in about 100 hours of game use.

Many high modulation games have been sold in the last two years but there have been few consumer complaints. This indicates that these games probably did not get used for the 100 to 200 hours which is sufficient to develop objectionable patterns. Since reduced modulation extends this time, it is unlikely any objectionable pattern will occur due to actual game playing time. There is some concern that the new programmable games may encourage more playing hours because of the diversity of games available. It still seems unlikely that any one game out of the many available cartridges would be played more than the earlier nonprogrammable games. The game cartridges should be designed, however, to avoid common stationary picture elements between different games.

The greatest danger of producing objectionable patterns on the screen of a television receiver will be caused by the users' failure to turn the game and/or the receiver off after play has ended. The only certain technique to prevent this is in the game design. One technique which has been described is that after a short interval of inactivity the game will switch the signal to produce a blank screen. Another technique is to automatically switch to a non-pattern producing mode after a period of inactivity. At present these techniques are the only known way to make the games fool proof. Because of the possibility of a large number of accumulated game hours, it is recommended that game manufacturers provide a warning regarding prolonged display of a non-moving pattern and the ultimate consequences. Games which can demonstrate no problem under the worst case might be exempt from such a disclosure.

TABLE I

Measured Modulation Levels of Each of Various Games

Game	Description	Modulation %	
		Peak-White	Black
A	Color - 4 variations of ball & paddle	41	69
B	Monochrome - Ball & paddle	13	75
C	Color - Ball & paddle plus programmable cartridges	10	71
D	Color - Programmable Cartridges	34	75
E	Monochrome - 5 games plus cartridges	50	88
F	Monochrome - 4 variations of ball & paddle	28	63
G	Color - 4 variation of ball & paddle	38	63
H	Color - programmable cartridges	25	63
I	Color - 8 variations of ball & paddle	25	50

Table 2

A Visual Rating Scale

Level	Receiver Power	Criteria	Possible User Reaction
0	OFF	No pattern visible on close inspection with bright light.	None
1	OFF	Some pattern visible on close inspection with bright light. Pattern outline not definable.	None
2	OFF	Faint pattern visible on close inspection with bright light. Outline definable.	Might be noticed by a critical user in bright room light. Probably would not be seen by most users in normal room light.
3	OFF	Visible pattern on inspection in normal room light.	Would be noticed by most users.
4	OFF	Obvious pattern visible in any light.	Would be seen by all users.
5	ON	Faint pattern visible depending on program scene.	Would be noticed by many viewers particularly on stationary uniform color patterns or on fades between scenes.
6	ON	Visible pattern on many broadcast program scenes.	Would be noticed by most users.

Table 3

Comparison of High vs Normal
Receiver Brightness Settings

Hours to reach level 3

Game	Receiver Setting	Color		Monochrome	
		High	Normal	High	Normal
A				310	330 ¹
B				105	170
C		240	430	240 ²	335 ²

¹Rating had not been reached at this number of operating hours.

²Reached level 4 at this number of operating hours.

Table 4

Comparison of Cycle vs Continuous
Operating Time

Hours to reach level 3

	Game B Cycle Operation	Game C Continuous Operation
Monochrome High Brightness	105	95
Monochrome Normal Brightness	170	95

Note: Color receivers did not reach
level 3 on game B.
No comparison is possible.

Table 5

Comparison of High Modulation
vs Reduced Modulation of
Game

Hours to Reach Level 3 Rating

Receiver \ Game	High Modulation Game B	Reduced Modulation Game A
Monochrome High Brightness	105	310
Monochrome Normal Brightness	170	330 ¹

¹ Rating had not been reached at this number of operating hours.

Note: Color receivers did not reach level 3.
No comparison is possible.

Table 6

Game Operating Hours To Achieve Rating Levels

TV Receiver	Reduced Modulation Game A			High Modulation Game B			High Modulation Game C			Reduced Modulation Game D				
	Rating Level	Cycle Operation	Hours	Cycle Operation	Hours	Hours	Continuous Operation	Hours	Hours	Hours	Varied Luminance When not in use.			
Color High Brightness	330 ¹	160	300 ¹	105	330 ¹	100 ²	240	100 ²	240	70	95	410 ¹		
Color Normal Brightness	330 ¹	105	330 ¹	105	330 ¹	100 ²	430	100 ²	430	Not Tested	Not Tested	Not Tested		
Monochrome High Brightness	90	135	310	55 ²	105	215	280	95 ²	240	240	430	70	95	410 ¹
Monochrome Normal Brightness	136	310	330 ¹	55 ²	170	300	280	95 ²	335	240	430	Not Tested	Not Tested	Not Tested

¹This rating had not been reached at this number of operating hours.

²First observation.

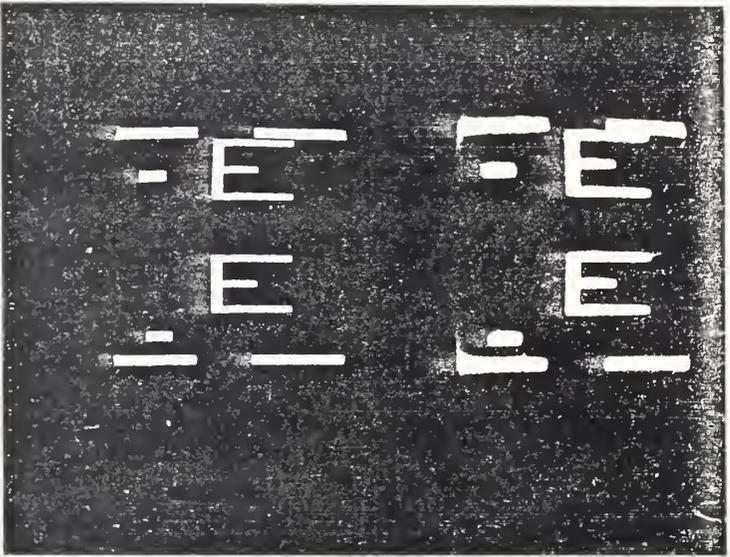


FIG. 1 Game B displayed on two monochrome receivers. The upper screen is on the receiver that has the brightness control set to a high level. The lower screen displays a normal brightness setting.

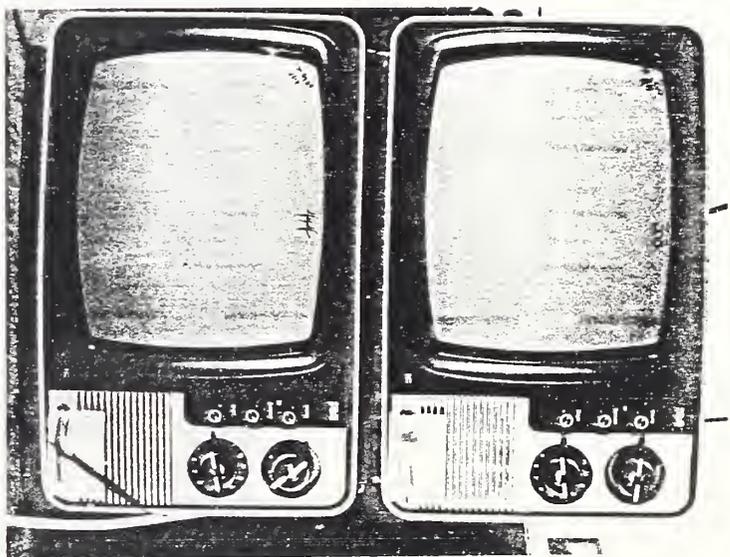


FIG. 2 Resultant pattern left on each screen after approximately 280 hours of game time. A visual rating of 3 was achieved in about 100 hours for the upper receiver.

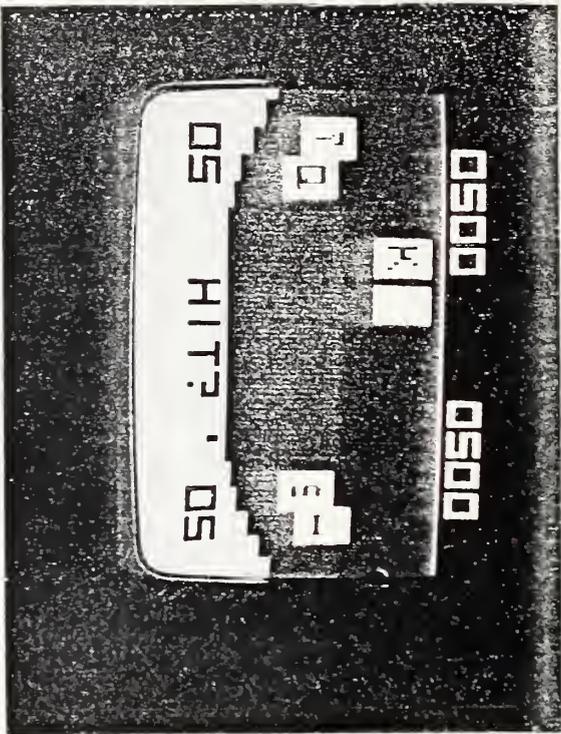


FIG. 3 A card game displayed on a 19 inch monochrome receiver by game C which is programmable by cartridges.

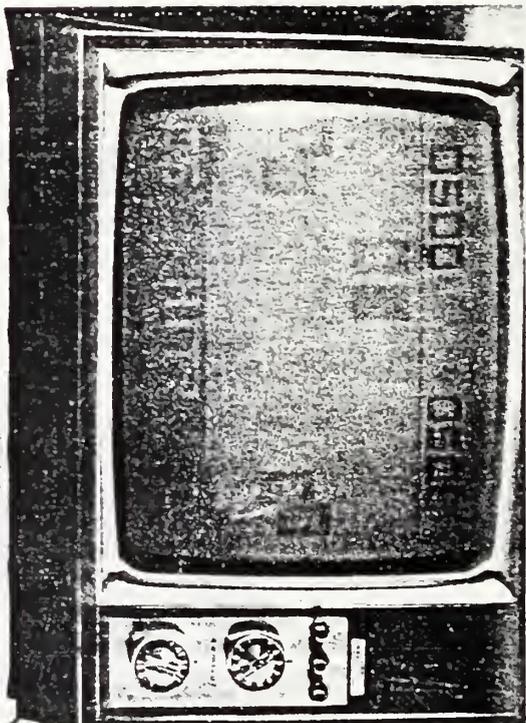


FIG. 4 The resultant pattern which remains on the screen after 430 hours of game time. A visual level of 3 was achieved in about 100 hours.

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